Reflections of a Weather Worn Meteorologist

David Atlas – June 23, 2009

How nice it is to be here with many young friends and over the hill colleagues to get a close-up view of the state of Earth System Science. Although I still attend seminars and read the literature, these are just fragments of the entire picture. What I have heard in the last two days is a magnificent symphony of science which none of us could have imagined.

In listening to Jeff Halverson's talk, I was overwhelmed by all the exciting insights that we have gotten about thunderstorms and hurricanes from TRMM and the ER-2 aircraft. It was a half century ago that we started a program to build an airborne Doppler radar to be flown in a B-57, but the existing technology was just not up to the task at that time. A few years later Lou Battan conducted studies of thunderstorms with a ground-based vertically pointing Doppler radar. That was a major breakthrough at the time, but primitive in retrospect. So you can see why I am so thrilled with the wealth of understanding that Jeff has described. Can you imagine how Lou Battan and Ted Fujita would have reacted?

The successful measurement of rainfall from space is a spectacular achievement. Much of my career has been devoted to radar rainfall measurement. To appreciate how far we have come I remind you that our first measurements of rain drop size were made by exposing dyed filter paper and counting the drops one by one: tens of thousands of them. **You guys are spoiled**. Fast forward from there to 1981 when a few of us conceived the method for measuring rain from space. This was followed by two decades of research by U.S. and Japanese scientists to turn it into workable algorithms. It is only with this perspective that one can measure the magnitude of what you have wrought.

Some of you may recall the Thunderstorm Project initiated in 1945 by Prof. Byers at Chicago with the support of the Weather Service, NACA, and the Air Force. I had the good fortune of working with Major Joe Fletcher* who assigned me to visit the Radar Test Facility at Orlando to select the

radars for that project. While there a hurricane occurred on Sept 15-16 1945. I grabbed a camera and took photos of the scope of the MEW radar for 36 hours, yielding the first comprehensive observations of hurricanes. Unfortunately I turned the photographs over to Hq, Air Weather Service where Major Harry Wexler later published them in the Transactions of the New York Academy of Science. That experience taught me two lessons: 1) to go in hot pursuit at every opportunity; and 2) don't let you're original data out of your hands. (A few years later Harry Wexler and I became good friends.)

Let me sight one more fortuitous event. In 1976 Charles Elachi invited me to JPL to propose a small radar for the Jupiter mission. While there he showed me a baffling picture of the ocean near Alaska taken with the 3 cm synthetic aperture radar (SAR) on the Convair 880. According to expectation there should have been no echoes at ranges less than the altitude of the aircraft. But there they were. Although we spent most of the day on other subjects the picture stuck in my mind – until I realized that the anomalous echoes must have been from rainfall, a hypothesis proven in a subsequent paper. Thus began my interest in radar observation of the ocean. A few years later I used the pattern on the sea seen by the SAR onboard the ERS-1 satellite to show how it was generated by the outflow winds of a thunderstorm on the U.S. coast. (Afterthought:- Charles Elachi is now the Director of the Jet Propulsion Labs in Pasadena. In 1976 he was already a recognized expert in radar, geology, and the planets. Why was he at a loss to explain the SAR observations? Clearly, it was a lack of familiarity with radar observations of precipitation, the area of my expertise. This is just one more example of discovery at the interface of two disciplines.)

Of course few of us are free of mistakes. In 1964 I made a whopper of a mistake in attempting to explain echoes from the clear air. Prof. Stewart Marshall of McGill University was merciless in tearing my hypothesis to shreds. But mistakes are significant steps in the scientific process. When the giant ultra-sensitive radars at Wallops Island were abandoned by Lincoln Lab, we jumped at the opportunity to take them over. Then we were able to make multi-wavelength measurements to prove

Tatarski's theory of turbulent scatter. At the same time we discovered the magnificent breaking waves in the atmosphere responsible for clear air turbulence.

By use of the word "we" I refer to the hundreds of scientists who comprised the remote sensing community while you were in short pants. Today's achievements are a tribute to the foundation that they set for you.

The lessons learned from these experiences are fundamental elements of creativity. To paraphrase Lewis Thomas (Lives of a Cell, 1974)…

"There is no cookbook for creativity; the targets are elusive, the search is broad, risky, and fraught with traps; and serendipity plays a key role. You can measure the quality of the work by the intensity of astonishment - surprise because it turned out as predicted; confoundment because the result was unexpected, thus requiring a new approach. Either way you win."

In this regard, I am amazed at the number of serendipitous applications of MODIS (on TERRA and AQUA) that were never imagined by its inventor, Michael King.

The two decades of Earth System Science are replete with exciting discoveries. I am ecstatic to have witnessed those of all of you here, as well as the breathtaking advances of the last 6 ½ have decades. I hope I shall be around for a while longer to witness many more of these thrilling moments in the years ahead.

* I mentioned Major Joseph O. Fletcher above. Few people recognize the role he played in the development of Radar Meteorology. Joe was both a meteorologist and a pilot. In 1941-42 he was flying anti-submarine patrol out of Langley Field in the hope of diminishing the losses of ships to German submarines. His squadron was the first to get the gerry-rigged 10 cm airborne radars developed at the MIT Radiation Labs in early 1942, thus leading to the sinking of a significant number of the submarines. While flying he noticed mysterious echoes on the radar scope – which turned out to be rain storms. He later convinced the commander of the Air Weather Service to send 100 weather

officers to the Radar School at Harvard and MIT; I was one of that group. In this respect I consider Joe to be the father of our discipline.